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Conflict of Interest Statement
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Abstract

Beliefs concerning the mental experiences of non-human animals have been related to how people treat, see and take care of non-human animals. Whereas this issue has been the subject of several studies on adults, few have been conducted with children. Taking advantage of a recently published scale, the Child-BAM questionnaire, we aimed to explore the beliefs in animal minds of Spanish primary school children. The study also considered the effects of a child's age, school year group, gender, and pet ownership on their beliefs in animal mind. The Child-BAM questionnaire, concerning the mental capabilities of eight different species (human, chimpanzee, dog, cow, otter, sparrow, frog and fish), was distributed at a primary school sited in Cordoba, Spain. A total of 416 participants were included aged between six and thirteen years. Each child provided scores for animals' ability to have intelligence, experience pain, fear, happiness, and sadness, and total scores for the eight species. The results showed that children's beliefs about animal minds differed depending on the type of animal, and that children were more likely to believe in emotional capacities of animals rather than their cognitive capabilities. Dogs achieved similar scores to humans regarding all capabilities, and higher than any other species, while the cow, fish and frog generally scored the lowest. Age, school year group, and having a companion animal at home affected beliefs in animal minds, whereas gender had no effect. This study highlights cultural similarities in children's beliefs about animal minds and the potential importance of this variable for

future research in child-animal interactions.

Keywords: animals; Child-BAM; belief in animal mind; children; sentience

INTRODUCTION

'Beliefs about animal minds' describes humans' beliefs concerning the mental experiences of non-human animals (Hawkins & Williams, 2016; Herzog & Galvin, 1997; Hills, 1993; 1995; Knight, Vrji, Cherryman, & Nankoosing, 2004). Herzog and Galvin (1997) found that there were two different components to adults' beliefs in animal's minds: cognitive abilities and emotional capabilities. Participants rated animals differently depending on animal cognition (consciousness, emotion, reasoning, self-awareness, and intelligence) and animal sentience (the capacity to suffer and feel pain). These authors also found what Knight, Bard, Vrij, and Brandon (2010) would confirm later, that adults rated animal capabilities in a way that might reflect the so-called 'phylogenetic scale', with 'lower' animals (e.g., frogs, snakes, fish) having lower scores for mental capabilities, whereas 'higher' species (e.g., chimpanzees, dogs, cats) were consistently rated near the top of the scale. The 'phylogenetic scale', otherwise known as '*the scala naturae*', is a hierarchical representation of the animal kingdom with human beings situated at the top of the scale, followed by 'higher' mammals and primates, and the rest of the animal kingdom positioned somewhere beneath these. Even though this theory is inconsistent with contemporary beliefs concerning animal evolution and has been largely defined as 'pleasingly simple, but simply wrong' (Lockard, 1971, p 168), it still seems to be widely accepted (Knight et al., 2010).

Beliefs about animal minds (BAM) are not homogeneous throughout society. They increase with age (Knight et al., 2004) and are affected by gender, with males presenting lower levels of these

beliefs than females (Herzog & Galvin, 1997). Familiarity with animals, in terms of animal ownership, has also been related to a higher level of conferral of emotions to animals (Morris, Knight & Lesley, 2012). In addition, it has consistently been shown that species is an important determinant of BAM (e.g., Driscoll, 1992; Eddy, Gallup & Povinelli, 1993; Herzog & Galvin, 1997). Research has also shown that people also tend to rate animals classified as pets (e.g., dogs and cats) as having higher mental abilities compared to those classified as non-pets (Eddy et al., 1993; Herzog & Galvin, 1997). Indeed, children have reported pets to be one of their closest members of their families (Morrow, 1998; Muldoon et al., 2014). Recently, Morris, Knight and Lesley (2012) suggested that the probability that people attribute mental capacities to certain species is linked to the perceived similarity between these species and humans.

BAM influences how we treat animals and whether we show concern for an animals' welfare. BAM has been found to be the most powerful and consistent predictor of attitudes towards animal use, where higher BAM was related to more pro-animal attitudes (Knight et al., 2004). It has also been strongly related with higher concern for animals and animal welfare (Broida, Tingley, Kimball & Miele, 1993; Ellingsen, Zanella, Bjerkås, & Indrebø, 2010; Herzog & Galvin, 1997; Knight et al., 2004), caring behaviour (Ellingsen et al., 2010; Kielland, Skjerve, Østerås, & Zanella, 2008), and empathy towards animals (Hills, 1995; Knight et al., 2004). This relationship might be explained in terms of the ability to attribute mental states to oneself and to others being a crucial element to empathizing (Baron-Cohen et al., 2002). By contrast, lower levels of BAM are associated with considering animals more as mechanical objects than as thinking, feeling creatures (Knight et al., 2004) and when people do not believe animals to be capable of thinking and feeling, they are more willing to support types of animal use such as farming or in research (Herzog & Galvin, 1997) and might even lead to misbehaviours towards animals (Knight et al., 2004). Moreover, low levels of belief in animal minds have been related to higher acceptance of animal cruelty in childhood (Hawkins & Williams, 2016).

Although there is a widespread belief in the emotional lives of animals among adults, little research has been carried out with children. The few studies that have been carried out have revealed that childhood BAM is associated with higher attachment to pets, and compassion, humane and caring behaviour towards animals, and less acceptance of animal cruelty (Hawkins & Williams, 2016) and may affect to how children interact and treat particular animals (Burghardt, 2009).

This study is the first to explore Spanish children's BAM. It also considers the influence of age, gender, school year group and pet ownership on BAM. The present research also examines the relationship between species of animal and children's belief in animal cognition and animal sentience. Such beliefs were measured concerning eight different species of animals, chosen to represent a range of animals in terms of their position on the phylogenetic scale and to include pet animals, farm animals and wild animals (e.g., chimpanzees, cows, dogs and sparrow).

Based on previous findings, it was hypothesised that: Children would rate each mental capability differently (Hypothesis 1); that BAM score for each species would differ (Hypothesis 2); that older children would show a higher BAM (Hypothesis 3); and that owning a companion animal would increase children's beliefs in the emotional lives of animals (Hypothesis 4).

MATERIAL AND METHODS

Participants

A total of 416 questionnaires were collected from children within one primary school in Cordoba, Spain (Table 1), with a response rate of 97.17%. The primary school was selected because of its size (three lines of primary, meaning three groups in each school year), kind of centre (state centre) and location (Cordoba, Spain).

This work was carried out with the consent of the head teacher and faculty of the primary school, and in accordance with the code of ethics of University of Cordoba, Spain (Universidad de Córdoba, 2015).

The age of the children surveyed ranged from six to thirteen years (Mean M=9.18; Standard Deviation SD= 1.73). Fifty-two children did not report their gender, nor if they have a pet at home.

– Table 1 around here –

Design

A questionnaire design was used in this study based on Child-BAM, Children's Beliefs about Animal Minds scale (Hawkins & Williams, 2016). It comprised five statements (e.g. 'Do you think the following animals are intelligent?') regarding eight different animal species, including human being, cow, dog, sparrow, frog, otter, chimpanzee and goldfish where they had to rate from 1 “fully disagree” to 5 “fully agree”. Two species from the original version, robin and badger, were replaced by sparrow and otter, looking for more common and recognizable species by children in Spain. This scale was designed to find out the belief of children regarding the capacity of animals to be intelligent, to feel pain, fear, happiness, and sadness. The statements were translated into Spanish following the back-translation procedure (Brislin, 1970).

In order to test the reliability of the scale, several consistency analyses were performed following Peters (2014): Cronbach’s alpha (Cronbach, 1951), omega (Revelle & Zinbarg, 2009), and the greatest lower bound to reliability index (glb; Sijtsma, 2009). Both the glb and omega are available in the free and open source package R (R Development Core Team, 2014).

The Child-BAM scale was demonstrated to be reliable within our Spanish population. This measure showed consistency indexes quite similar to those originally published (α=0.903; omega= 0.93; glb=0.85), which confirms that neither the translation nor the changes of species to make it

appropriate for the Spanish context had any detrimental effects on its reliability.

Procedure

The head teacher of the school was personally contacted by the first author, provided information on the study – questionnaire and supplementary materials, inviting the school to take part in it. Once consent was obtained from the head teacher and faculty of the primary school, questionnaires were distributed among teachers with an information sheet which explained the aim of the survey, and how to carry out it with their pupils. They were asked not to influence the children's answers, but to help them when they did not understand some statements.

The survey was carried out during class time. All children received the questionnaire, and a sheet with images of a man and a woman, a dog, an otter, a chimpanzee, a sparrow, a goldfish, a cow and a frog so as that it could be affirmed that all children were thinking of the same types of animal. Each image was labelled with its correspondent name. Each child completed the questionnaire individually at their classroom desks and could ask for help from a teacher if they had difficulty in reading or understanding any of the questions. The questionnaire used appropriate terminology for the age group and did not collect any personal details beyond their gender, age and pet ownership.

Coding

The coding criteria was similar to the original rating system (1 ‘fully disagree’ to 5 ‘fully agree’). In the questionnaire design, a children-friendly visual rating system made of star pictures, from one star to five stars, was included. Statements were coded so that higher scores represented higher perception of animals' capabilities, meaning higher levels of BAM.

From children's responses in this part, we calculated several scores. First, total scores for each emotion across participants were calculated for each animal type so that we had partial scores for intelligence, pain, fear, happiness and sadness ability of each species Secondly, total BAM scores

were calculated across sentience items for each animal as well as a total BAM score across animals. Additionally, scores for fear, pain, happiness and sadness were aggregated in a new variable called 'sentience' for each animal as well as across animals. Scores for intelligence ratings were used for a subcategory referred to here as 'cognition'. Both subcategories of ‘sentience’ and ‘cognition’ are analysed in detail as well as total BAM scores across categories.

Statistical Analyses

Since the majority of variables failed to fulfil the criteria of equal variance and normal data distribution (Kolmogorov-Smirnov normality test $p<0.001$), non-parametric statistical tests were applied. Related-samples Friedman's Two-Way analysis of variance was performed to analyse differences between subcategories – mental capabilities – and species. Post-hoc pairwise comparisons were performed later to confirm significant differences. Spearman's rank correlation coefficients were performed to identify the linear correlation between subcategories, species and personal variables of respondents.

RESULTS

Child-BAM scores

As predicted, children differentiated between different species in terms of BAM (Table 2). The Related-samples Friedman's Two-Way analysis of variance showed that scores between species were significantly different ($p<0.001$). Post-hoc pairwise comparison established that children rated dogs and humans the same on sentience (Adj. $p=0.445$), and both were rated as higher in BAM over any other species (Adj. $p<0.001$). Chimpanzee, otter and sparrow were rated as similar (Adj. $p=1$), with lower ability than humans and dogs, but higher than cows, goldfish and frogs (Adj. $p<0.001$).

Cows and goldfish were rated as similar (Adj. p=1), but higher than frogs (Adj. $p_{\text{cow-frog}}$<0.001; Adj. $p_{\text{goldfish-frog}}$=0.023) which received the lowest scores.

– Figure 1 around here –

– Table 2 around here –

Belief in Animal Cognition (intelligence) and Belief in Animal Sentience (aggregate of pain, fear, happiness, and sadness) were quite different as well, as Table 3 and Figure 2 show. Related-samples Friedman's Two-Way analysis of variance showed that they were scored differently (p<0.001) in all species (Adj. p<0.01) except human beings.

– Table 3 around here –

– Figure 2 around here –

Table 4 shows means, standard deviation and median values for all Child-BAM subcategories. Pain was scored highest, while intelligence the lowest. Partial BAM scores for all subcategories, mental capabilities, were analysed by a Related-samples Friedman's Two-Way analysis of variance (p<0.001), showing that scores between subcategories were significantly different (Adj. $p_{\text{happiness-sadness}}$=0,015; Adj. $p_{\text{other pairs}}$<0.001) except for *Fear* and *Sadness* scores that were similar (Adj. p=1). Nevertheless, all of them were clearly intertwined, judging by their correlation values (Table 3).

– Table 4 around here –

Similarly, species' scores showed significant positive correlations (Table 5). The strongest correlation was found between cow and frog scores (.710), also noteworthy were the correlations between sparrow and frog (.670); frog and goldfish (.653); sparrow and cow (.635); sparrow and goldfish (.626); sparrow and otter (.622).

– Table 5 around here –

Analysis of variance of each animal ability

Related-samples Friedman's Two-Way analysis of variance by ranks were performed among each partial BAM scores for all subcategories, mental capabilities ($p<0.001$ for each subcategory; Tables 2 and 3). Scores given to humans and dogs were similar and higher than other species scores for all subcategories, while cows, frogs and goldfish would rate the lowest. Otters, chimpanzees and sparrows were almost always rated lower than humans and dogs, but higher than cows, frogs and goldfish.

Regarding beliefs in 'sentience', trends for the aggregate variable computed from pain, fear, happiness and sadness scores, was similar. Humans and dogs' sentience ability were similar and higher than any other species, while goldfish and frogs were rated the lowest. Other species were rated within these two ends.

Personal variables and belief in animal mind

Correlations and categorical regression analyses were conducted to examine the predictive value of participant variables on BAM scores (see Tables 6 and 7).

– Tables 6 & 7 around here –

Correlations between participant variables and belief in animal mind

First, being older was related to higher scores on pain, fear, and sadness animal ability (Table 6). Similarly, it was also related to giving a higher ability to dogs, cows, humans, frogs, otters and chimpanzees (Table 7). Meanwhile, belonging to a higher school year group was related to higher scores on fear (Table 6), and to giving a higher ability to dogs, cows, humans, frogs and

chimpanzees (Table 7).

246 ***Personal variables as a predictor of belief on animal mind (Child-BAM)***

Categorical Regression analysis showed that owning a dog had some influence on intelligence
248 ($F_{1,409}$=9.447; p=0.002; Adj. R^2=0.02) and pain scores ($F_{5,402}$=3.557; p=0.004; Adj. R^2=0.031). Those children owning a dog scored animals higher on intelligence (Median = 3.87) and lower on
250 pain subcategories (Median = 4.75) than those who not (Intelligence scores Median = 3.62; Mann-Whitney U test p=0.001; Pain scores Median = 5; Mann-Whitney U test p=0.01). Similarly, owning
252 a reptile had some effect on fear rating scores ($F_{4,402}$=6.218; p<0.001; Adj. R^2=0.049) in which those children who owned a reptile, scored animals higher on the ability to feel fear (Median =
254 4.62) than those who did not (Median = 4.25; Mann-Whitney U test p=0.031).

This analysis also showed that age affected children's ratings of animals ability to feel pain
256 ($F_{5,402}$=3.557; p=0.004; Adj. R^2=0.031) and fear ($F_{4,402}$=6.218; p<0.001; Adj. R^2=0.049). Table 8 shows means, standard deviations and medians of animals' ability to feel pain and fear scores by
258 age. Regarding pain, seven-year-old children rated animals the lowest, while Thirteen-year-old children scored animals the highest. For fear, six-year-old children scored the lowest, while twelve-
260 year-old children scored the highest.

– Table 8 around here –

262 **DISCUSSION**

Our principal aim was to study Spanish primary school children's belief in animal mind, using a
264 recently published UK-based measure, the Child-BAM (Hawkins & Williams, 2016). Despite the translation and the changes performed in the scale, to make it more suitable for Spanish children, it
266 showed a strong reliability, highly comparable to the original UK version. Furthermore, the Child-

BAM answers in the current study were also quite similar to those published by Hawkins and Williams (2016), suggesting this scale is useful for a range of national and geographical contexts.

The results reveal that among Spanish children, there is widespread belief in the emotional lives of animals, regardless of species, age and gender. High BAM is desirable in children because it has been associated with caring and humane behaviour, concern for animals' well-being, empathy, compassion and emotional attachment to pets, positive attitudes towards animals, and lower acceptance of intentional and unintentional animal cruelty and animal neglect (Ellingsen et al., 2010; Hawkins & Williams, 2016; Herzog & Galvin, 1997; Hills, 1995; Knight et al., 2004).

As expected, children rated humans and dogs as the most sentient beings, while cows, frogs and fish as the least. Dogs have been rated highly on sentience in previous studies (Hawkins & Williams, 2016; Morris, Knight & Lesley, 2012), potentially as the result of a higher level of interaction and attachment to human beings.

Overall, based on previous literature (Borgi & Cirulli, 2015; Knight et al., 2010; Wilkins, McCrae & McBride, 2015), we expected to find that children were more likely to rate animals phylogenetically closer to humans, with chimpanzees at the top of sentience, followed by dogs, otters, and cows as large-brained animals in the middle, and smaller-brained animals such as frogs and fish at the bottom. Instead, we found that children did not always follow such criteria, scoring sparrows higher in BAM than cows for instance, even at the same level of chimpanzees. This deviation might be caused by a lack of the necessary cognitive maturity, as Hawkins and Williams (2016) suggested, but there may be further explanations. For instance, Spanish children rated higher sparrows' minds than Scottish children rated robins' minds (Hawkins & Williams, 2016). Sparrows are quite common birds in Spanish cities, therefore children are very familiar with them and have extensive experience of observing them and their behaviour in their natural environment. It is also quite common in Spain for children to take care of chicks that have fallen from their nests during

the late spring because of the hot temperature, especially in Andalusia region with its really warm springs. This kind of experience would provide children a closer and caring contact with this species, which likely influences their perception of sparrow's abilities and potentially their compassion and attachment to them.

While Spanish children have a belief in animal minds they are not consistent in how much of these abilities they believe animals have, and indeed they scored each Child-BAM subcategory differently. For instance, children were more likely to believe that animals have the ability to feel pain than to suffer fear, or to be intelligent. Perhaps the belief that animals feel pain is a commonly cultural belief that is conveyed to children in families and schools. By contrast, attributing intelligence to animals might be more difficult for children to believe because it may not be as salient in an animal's behaviour, and is demonstrated in different ways by different species. Indeed, cognitive ability (intelligence) was rated lower than sentience abilities for all species except for human beings.

Nevertheless, Spanish children, like UK children, rated dogs as intelligent beings. In fact, they rated them as similar in intelligence to humans. Again, our proximity with this species as a familiar and popular companion animal means that children have extensive experience of interacting with dogs and observing their behaviour. On the other hand, children overwhelmingly rated cows, frogs and goldfish as the least intelligent species, in-keeping with Scottish children's views, at least when it comes to frogs and fish. Humans have been reported as having more intense relationships with animals that are phylogenetically closer to themselves (Batt, 2009; Serpell, 2004), but children appear to prefer pet animal species that can be touched and cuddled, which engage in physical activities, and in which the behavioural responsiveness supports anthropomorphic play (Gebhard, 2013 in Hirschenhauser Meichel, Schmalzer & Beetz, 2017). Hirschenhauser et al. (2017) argue that this type of play is more easily realized with dogs or cats than turtles or fish. They found that

those children owing dogs or cats reported a stronger attachment to their pet than children with pet species such as turtles and fish.

Cows might not be familiar animals to urban Spanish children, as there is little contact beyond an occasional visit to a farm school. The same could be said for frogs, even though many children enjoy looking for them in Spring in the countryside. Regarding fish, the lack of interaction between them and their owners might make children think they do not do anything more than swim and eat (Muldoon, Williams & Lawrence, 2016).

Pet preferences and understanding of animal minds might develop with age. In our study, older children scored higher on BAM, especially animal ability to feel pain or fear. This result is in keeping with previous research (Hawkins & Williams, 2016) but contradicts others. Indeed, Hirschenhauser et al. (2017) found that children's attachment to their pet diminished in older children between 11 to 14 years of age, probably because of a worsening of interest in pets with increasing age (Borgi & Cirulli, 2015). These variations might well be explained by changes of emotional concern for animals, understanding and knowledge of animals (Kellert, 1984).

In this study, there was no evidence of gender differences in Spanish children's BAM. This finding is completely consistent with Hawkins & Williams (2016) UK outcomes, and it is interesting given the evidence from some studies of gender differences in empathy, and gender differences in attachment to pets (e.g. Hirschenhauser et al., 2017). BAM includes both beliefs about cognitive ability and sentience and therefore may be more robust in terms of gender than purely affective variables.

Ownership of animals has been consistently highlighted as an important influence on BAM and we have demonstrated this finding in Spanish children. Our results suggest that owning a pet, particularly a dog or even a reptile, influences children's BAM. Surprisingly enough, children

owning a dog scored animal's ability to feel pain lower, but they also accepted more easily that animals can be intelligent or suffer fear. Hawkins & Williams (2016) also found that those who had a pet of their own scored higher on BAM that those who did not. The perceived capacity of animals to experience pain and suffering has the most influence on attitudes (Plous, 1993), so if owning a pet has a positive effect on owners' perception, a positive effect on their attitudes should also be expected. Furthermore, owning a particular animal type has been shown to increase the number of emotions reported in that animal compared to non-owners of that animal (Morris, Knight & Lesley, 2012). Perhaps belief in animal emotion, may be a result in emotional attachment to a particular type of animal rather than simple ownership of such an animal. Carporael and Hayes (1997) affirmed that pet owners beliefs in animal emotion might be due to the extent to which they have engaged socially with their own animals. Kiesler, Lee and Kramer (2007) found that affection rather than ownership explained variation on owners' perception of their animals' behaviours.

Limitations and future research

Some personal attributes seemed to influence children's BAM. Nevertheless, the models showed that they explained a very limited amount of variance. Therefore, additional factors should be included in future research, i.e. attachment to pets, or parents' attitudes towards animals. In this study we did not ask about the relationship children had with their pet, so we could not distinguish different levels of attachment to pets. Knight et al (2014) suggested that there should be different effect for different attachment levels. In the same way, Paul & Serpell (1993) affirmed that experience of animals should be measured in terms of quality of relationships rather than contact alone. Indeed, Walker et al (2014) recommended a distinction between 'owner' from 'care-giver'. A range of studies have highlighted the importance of attachment to pets in children's development and relationships with animals (Hawkins, Williams & Scottish SPCA, 2017; Marsa-Sambola et al., 2016; Marsa-Sambola et al., 2017). Therefore, in future research, items on owing a pet should be

362 accompanied by pet care questions, and a pet attachment scale, in order to reflect the kind of bond between owner and companion animal.

364 Collecting the answer from just one primary school might have contributed to a biased data set, with answers restricted to a narrow spectrum, causing difficulties with extracting useful information
366 regarding possible influence of personal attribute. Different schools, i.e. rural schools, and smaller schools, should be included in future research.

368 **CONCLUSIONS**

Child-BAM was found to be a useful measure of beliefs about animal minds in Spanish children.
370 The results suggest many similarities between UK children, and Spanish children regarding BAM. Children rated species mind abilities differently. Humans and dogs were perceived as similar in
372 cognitive and sentience capabilities, followed by chimpanzees, sparrows, and otters. Cows, frogs, and fish were rated as the least sentience species. Furthermore, Spanish children differentiated
374 species in terms of BAM. Ability to feel pain was the most frequently acknowledged ability, while intelligence was the least acknowledged ability. Age differences were identified but there were no
376 gender differences in children's BAM. Owning a pet, at least in the case of dogs and reptiles, was found to influence some aspects of BAM. These results highlight cultural similarities in children's
378 BAM and the potential importance of this variable for future research in child-animal interactions.

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Tables

Table 1. Participant information.

Variable	Number	%
Gender		
Female	179	43.03
Male	185	44.47
School Year Group		
1	46	11.06
2	42	10.10
3	101	24.28
4	81	19.47
5	70	16.83
6	76	18.27
Age		
6	30	7.2
7	42	10.1
8	79	19.0
9	80	19.2
10	80	19.2
11	60	14.4
12	36	8.7
13	5	1.2
Animals Owned		
Yes	302	72.60
No	62	14.90
Type of Animals at home		
Dogs	183	43.99
Birds	75	18.03
Cats	53	12.74
Small mammals	42	10.10
Turtles and other reptiles	41	9.86
Fish	32	7.69

Tables

Table 2. Phylogenetic differences in ratings of Child-BAM. Means, Standard Deviations (SD), Medians and Pairwise comparisons adjusted p value are shown. High scores mean high cognition (intelligence) or sentience (pain, fear, happiness and sadness). Related-Samples Friedman's Two-Way Analysis of Variance by Ranks conducted in both Intelligence and Sentience variables confirmed the differences between species ($p<0.001$). ns= non significant.

Animals in order of...										
Intelligence	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**O**	**Ch**	**S**	**G**	**Co**
Human (H)	4.82	0.59	5	ns						
Dog (D)	4.56	0.78	5	ns	ns					
Otter (O)	3.93	1.09	4	<0.001	<0.001	ns				
Chimpanzee (Ch)	3.93	1.37	4	<0.001	<0.001	ns	ns			
Sparrow (S)	3.72	1.14	4	<0.001	<0.001	ns	0.05	ns		
Goldfish (G)	3.18	1.38	3	<0.001	<0.001	<0.001	<0.001	<0.001	ns	
Cow (Co)	3.03	1.22	3	<0.001	<0.001	<0.001	<0.001	<0.001	ns	ns
Frog (F)	2.80	1.34	3	<0.001	<0.001	<0.001	<0.001	<0.001	ns	ns
Sentience	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**Ch**	**S**	**O**	**Co**	**G**
Human (H)	4.80	0.55	5	ns						
Dog (D)	4.75	0.52	5	ns	ns					
Chimpanzee (Ch)	4.37	0.80	4.75	<0.001	<0.001	ns				
Sparrow (S)	4.34	0.72	4.5	<0.001	<0.001	ns	ns			
Otter (O)	4.29	0.79	4.5	<0.001	<0.001	ns	ns	ns		
Cow (Co)	4.22	0.77	4.5	<0.001	<0.001	<0.01	ns	ns		
Goldfish (G)	3.98	0.97	4.25	<0.001	<0.001	<0.001	<0.001	<0.001	<0.05	ns
Frog (F)	3.92	0.92	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	ns

Tables

Table 3 Phylogenetic differences in ratings of Child-BAM (pain, fear, happiness and sadness). Means, Standard Deviations (SD) and Medians and Pairwise comparisons adjusted p value are shown. Higher scores mean higher perception of animal ability to feel. Related-Samples Friedman's Two-Way Analysis of Variance by Ranks conducted in Pain, Fear, Happiness and Sadness variables confirmed the differences between species ($p<0.001$). ns= non significant.

Animals in order of the ability to feel...										
Pain	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**S**	**Co**	**Ch**	**O**	**G**
Human (H)	4.85	0.65	5	ns						
Dog (D)	4.83	0.61	5	ns	ns					
Sparrow (S)	4.58	0.88	5	<0.01	ns	ns				
Cow (Co)	4.56	0.89	5	<0.01	<0.05	ns	ns			
Chimpanzee (Ch)	4.50	1.06	5	<0.01	ns	ns	ns	ns		
Otter (O)	4.48	0.98	5	<0.01	0.001	ns	ns	ns	ns	
Goldfish (G)	4.28	1.21	5	<0.01	<0.001	ns	ns	ns	ns	ns
Frog (F)	4.24	1.18	5	<0.01	<0.001	<0.01	<0.01	<0.01	ns	ns
Fear	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**S**	**O**	**Ch**	**Co**	**G**
Human (H)	4.70	0.94	5	ns						
Dog (D)	4.57	1.01	5	ns	ns					
Sparrow (S)	4.23	1.13	5	<0.001	0.001	ns				
Otter (O)	4.11	1.17	5	<0.001	<0.001	ns	ns			
Chimpanzee (Ch)	4.09	1.30	5	<0.001	<0.001	ns	ns	ns		
Cow (Co)	4.01	1.26	5	<0.001	<0.001	ns	ns	ns	ns	
Goldfish (G)	3.98	1.38	5	<0.001	<0.001	ns	ns	ns	ns	ns
Frog (F)	3.80	1.28	4	<0.001	<0.001	<0.001	<0.01	<0.001	ns	<0.05
Happines	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**Ch**	**S**	**O**	**Co**	**G**
Human (H)	4.94	0.35	5	ns						
Dog (D)	4.94	0.36	5	ns	ns					
Chimpanzee (Ch)	4.56	0.97	5	<0.01	<0.01	ns				
Sparrow (S)	4.41	0.94	5	<0.001	<0.001	ns	ns			
Otter (O)	4.40	0.95	5	<0.001	<0.001	ns	ns	ns		
Cow (Co)	4.22	1.10	5	<0.001	<0.001	<0.001	ns	ns	ns	
Goldfish (G)	3.94	1.36	5	<0.001	<0.001	<0.001	<0.01	<0.01	ns	ns
Frog (F)	3.83	1.35	4	<0.001	<0.001	<0.001	<0.001	<0.001	<0.01	ns
Sadness	**Mean**	**SD**	**Median**	***Pairwise comparisons' adjusted p values***						
				H	**D**	**Ch**	**O**	**S**	**Co**	**F**
Human (H)	4.76	0.82	5	ns						
Dog (D)	4.71	0.89	5	ns	ns					

Chimpanzee (Ch)	4.40	1.06	5	0.001	<0.05	ns				
Otter (O)	4.26	1.13	5	<0.001	<0.001	ns	ns			
Sparrow (S)	4.17	1.13	5	<0.001	<0.001	ns	ns	ns		
Cow (Co)	4.12	1.21	5	<0.001	<0.001	<0.05	ns	ns	ns	
Frog (F)	3.83	1.27	4	<0.001	<0.001	<0.001	<0.001	<0.01	<0.05	ns
Goldfish (G)	3.73	1.42	4	<0.001	<0.001	<0.001	<0.001	<0.01	<0.01	ns

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500 Tables

Table 4. Means, Standard Deviation (SD), medians and Spearman's rho correlation coefficient

502 among Child-BAM categories.

	INTELLIGENCE	PAIN	FEAR	HAPPINESS	SADNESS	Sentience
Mean ± SD	3.75 ± 0.65	4.53 ± 0.72	4.18 ± 0.79	4.40 ± 0.62	4.24 ± 0.81	4.33 ± 0.58
Median	3.75	5	4.37	4.5	4.5	4.47
INTELLIGENCE		.226***	.353***	.303***	.262***	.394***
PAIN			.522***	.266***	.407***	.658***
FEAR				.340***	.448***	.795***
HAPPINESS					.601***	.695***
SADNESS						.808***
***. Correlation is significant at the 0.001 level (2-tailed).						

504

506 Tables

Table 5. Pearson's correlation coefficient among species Child-BAM scores.

	Dog	Cow	Human	Sparrow	Frog	Otter	Chimpanzee
Cow	.357***						
Human	.355***	.141**					
Sparrow	.312***	.635***	.151***				
Frog	.283***	.710***	.145**	.670***			
Otter	.404***	.580***	.289***	.622***	.590***		
Chimpanzee	.443***	.481***	.289***	.332***	.436***	.511***	
Goldfish	.190***	.554***	.135**	.626***	.653***	.502***	.178***

***. Correlation is significant at the 0.001 level (2-tailed) **. Correlation is significant at the 0.01 level (2-tailed)

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Tables

Table 6. Spearman's rho correlation between personal variables and Child-BAM scores

	Intelligence	Pain	Fear	Happiness	Sadness	Sentience
Age	.078	.105*	.177**	.074	.102*	.171***
school year group	.066	.083	.159**	.069	.077	.150**
Gender	.004	.054	.026	.066	.062	.063

*** Correlation is significant at the 0.001 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

Tables

Table 7. Spearman's rho correlation between personal variables and Child-BAM scores by species.

	Dog	Cow	Human	Sparrow	Frog	Otter	Chimpanzee	Goldfish
Age	.202***	.173***	.139**	.044	.121*	.122*	.392***	-.040
school year group	.201***	.140**	.134**	.010	.104*	.095	.395***	-.071
Gender	-.016	-.037	.035	-.032	-.071	-.038	.026	-.053

*** Correlation is significant at the 0.001 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).

522 Tables

524 Table 8. Means, Standard Deviation and Medians of animals ability to feel pain and fear by age of respondents.

526

	Pain			Fear		
Age	Mean	Standard Deviation	Median	Mean	Standard Deviation	Median
6	4.33	1.04	4.88	3.82	1.19	4.20
7	4.23	0.92	4.50	3.96	0.97	4.38
8	4.46	0.78	5.00	3.96	0.82	4.13
9	4.61	0.72	5.00	4.18	0.78	4.38
10	4.53	0.65	4.88	4.36	0.61	4.50
11	4.66	0.50	5.00	4.37	0.61	4.50
12	4.60	0.56	5.00	4.39	0.56	4.33
13	4.95	0.07	5.00	4.08	0.80	3.63

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532 Figures

Figure 1. Mean total scores for each animal species. Species has been sorted following *'the scala*
534 *naturae*' Those with different subscripts showed significant differences following Related-samples Friedman's Two-Way analysis of variance and post-hoc pairwise comparison.

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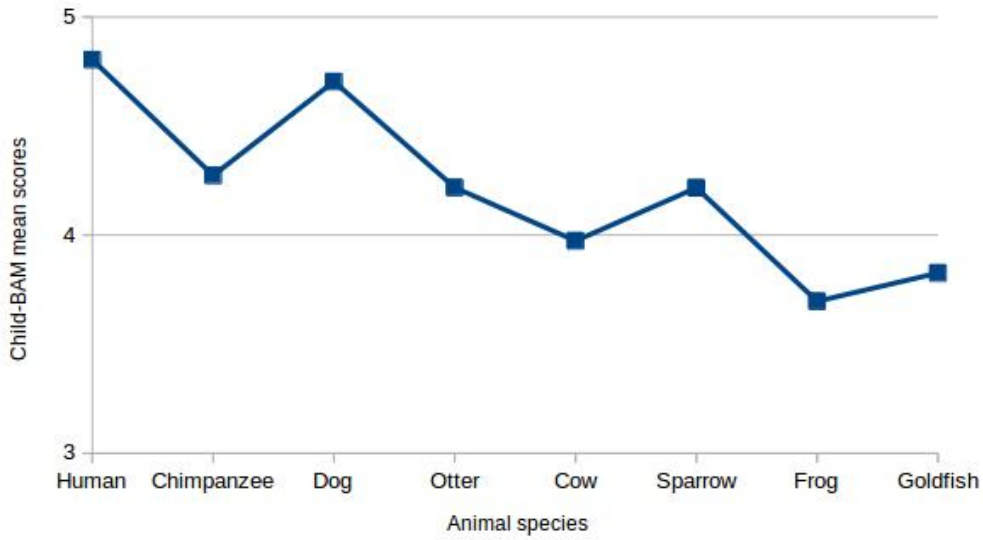

538 Figures

Figure 2. Sentience and Cognition ratings by species. Sentience value is the mean value calculated
540 from Pain, Fear, Happiness and Sadness scores. Cognition is intelligence score. Pairwise comparisons after Related-samples Friedman's Two-Way analysis of variance ($p<0.001$) showed
542 that all species but human were rated differently (Adj. $P<0.01$).

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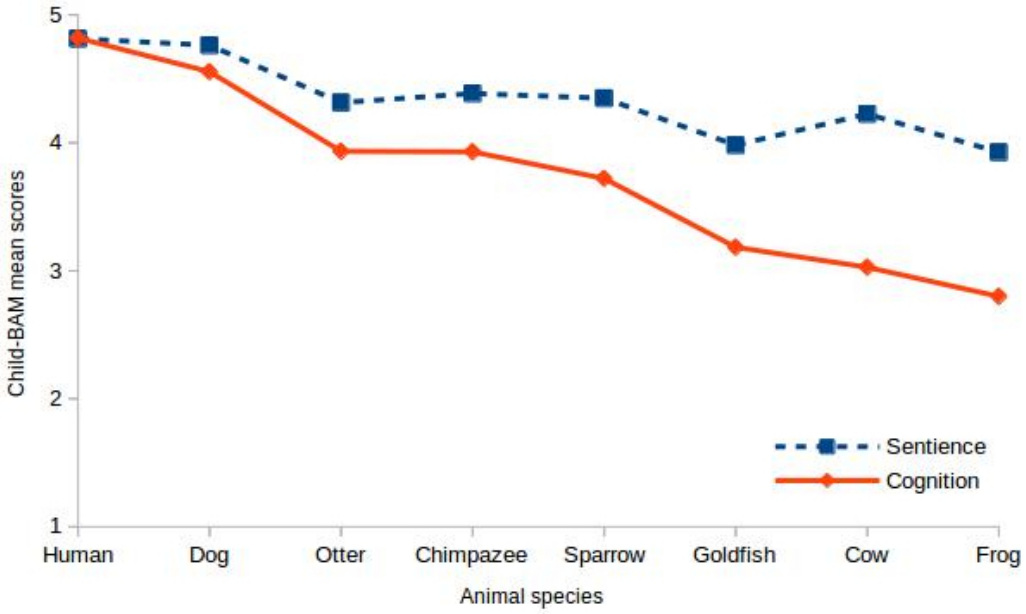

FIGURE CAPTIONS

Figure 1. Mean total scores for each animal species. Species has been sorted following '*the scala naturae*' Those with different subscripts showed significant differences following Related-samples Friedman's Two-Way analysis of variance and post-hoc pairwise comparison.

Figure 2. Sentience and Cognition ratings by species. Sentience value is the mean value calculated from Pain, Fear, Happiness and Sadness scores. Cognition is intelligence score. Pairwise comparisons after Related-samples Friedman's Two-Way analysis of variance ($p<0.001$) showed that all species but human were rated differently (Adj. $p<0.01$).